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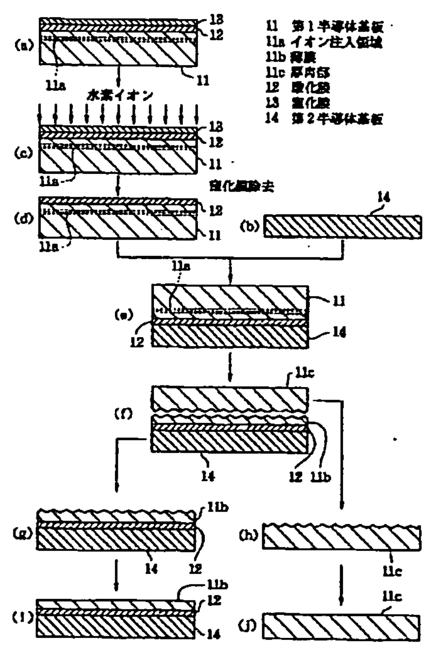
(54)【発明の名称】　SOI基板の製造方法

(57)【要約】

【課題】　半導体層が酸化膜を介して半導体基板上に重ね合わされているSOI基板において、酸化膜と半導体基板との界面の引張り結合強度を増大させる。

【解決手段】　第1半導体基板11の表面に酸化膜12を形成する。酸化膜12上に窒化膜13を形成する。第1半導体基板の表面から水素イオンを注入して第1半導体基板内部にイオン注入領域11aを形成する。窒化膜13を第1半導体基板から除去する。第1半導体基板を酸化膜12を介して第2半導体基板14に重ね合わせて密着させる。第1半導体基板を第2半導体基板に密着させたまま熱処理して第1半導体基板をイオン注入した領域11aで第2半導体基板から分離して第2半導体基板の表面に半導体層11bを形成する。表面に半導体層11bを有する第2半導体基板を更に熱処理する。



【特許請求の範囲】

【請求項1】　第1半導体基板(11)の表面に酸化膜(12)を形成する工程と、
前記第1半導体基板(11)の酸化膜(12)上に窒化膜(13)を形成する工程と、
前記第1半導体基板(11)の表面から水素イオンを注入して前記第1半導体基板(11)内部にイオン注入領域(11a)を形成する工程と、
前記窒化膜(13)を前記第1半導体基板(11)から除去する工程と、
前記第1半導体基板(11)を前記酸化膜(12)を介して第2半導体基板(14)に重ね合わせて密着させる工程と、
前記第1半導体基板(11)を第2半導体基板(14)に密着させたまま所定の温度で熱処理して前記第1半導体基板(11)を前記イオン注入した領域(11a)で前記第2半導体基板(14)から分離して前記第2半導体基板(14)の表面に半導体層(11b)を形成する工程と、
表面に半導体層(11b)を有する前記第2半導体基板(14)を更に熱処理する工程とをこの順に含むＳＯＩ基板の製造方法。

【請求項2】　第1半導体基板(11)の表面に酸化膜(12)を形成する工程と、
前記第1半導体基板(11)に前記表面から水素イオンを注入して前記第1半導体基板(11)内部にイオン注入領域(11a)を形成する工程と、
前記第1半導体基板(11)の酸化膜(12)を酸素プラズマ処理する工程と、
前記第1半導体基板(11)を前記酸化膜(12)を介して第2半導体基板(14)に重ね合わせて密着させる工程と、
前記第1半導体基板(11)を第2半導体基板(14)に密着させたまま所定の温度で熱処理して前記第1半導体基板(11)を前記イオン注入した領域(11a)で前記第2半導体基板(14)から分離して前記第2半導体基板(14)の表面に半導体層(11b)を形成する工程と、
表面に半導体層(11b)を有する前記第2半導体基板(14)を更に熱処理する工程とをこの順に含むＳＯＩ基板の製造方法。

【請求項3】　第1半導体基板(11)の表面に酸化膜(12)を形成する工程と、
前記第1半導体基板(11)に前記表面から水素イオンを注入して前記第1半導体基板(11)内部にイオン注入領域(11a)を形成する工程と、
前記第1半導体基板(11)の酸化膜(12)の表面を研磨する工程と、
前記第1半導体基板(11)を前記酸化膜(12)を介して第2半導体基板(14)に重ね合わせて密着させる工程と、
前記第1半導体基板(11)を第2半導体基板(14)に密着させたまま所定の温度で熱処理して前記第1半導体基板(11)を前記イオン注入した領域(11a)で前記第2半導体基板(14)から分離して前記第2半導体基板(14)の表面に半導体層(11b)を形成する工程と、
表面に半導体層(11b)を有する前記第2半導体基板(14)を更に熱処理する工程とをこの順に含むＳＯＩ基板の製造方法。

【発明の詳細な説明】

【０００１】

【発明の属する技術分野】本発明は、絶縁膜上に半導体層を設けたＳＯＩ（Silicon On Insulator）基板の製造方法に関するものである。

【０００２】

【従来の技術】この種のＳＯＩ基板は将来の超高集積回路（ＵＬＳＩ）基板として注目されてきている。このＳＯＩ基板の製造方法には、①シリコン基板同士を絶縁膜を介して貼り合わせる方法、②絶縁性基板又は絶縁性薄膜を表面に有する基板の上にシリコン薄膜を堆積させる方法、③シリコン基板の内部に高濃度の酸素イオンを注入した後、高温でアニール処理してこのシリコン基板表面から所定の深さの領域に埋込みシリコン酸化層を形成し、その表面側のＳｉ層を活性領域とするＳＩＭＯＸ法などがある。また最近、半導体基板に水素イオン等の注入を行った後に、この半導体基板をイオン注入面を重ね合せ面として支持基板に重ね合せ、この積層体を５００℃を越える温度に昇温して上記半導体基板を上記水素イオン等を注入した領域で支持基板から分離し、支持基板の表面に薄膜を有する薄い半導体材料フィルムの製造方法が提案されている（特開平５－２１１１２８）。この方法では、イオンを半導体基板の内部に表面から均一に注入できれば、均一な厚さの薄膜を有する半導体基板が得られる。また支持基板の表面に予め酸化膜を設けておけば、この方法によりＳＯＩ基板を製造することができる。

【０００３】

【発明が解決しようとする課題】しかし、上記水素イオン注入が行われる半導体基板の酸化膜表面において、水素イオンを注入する前に酸化膜表面に残留した有機物などの汚染物質が水素イオン注入によって変質し通常のウエットエッチングでは除去され難くなり、また酸化膜表面に面荒れが生じる問題がある。その結果、上記汚染物質と面荒れの影響により、上記半導体基板の酸化膜と支持基板との界面の引張り結合強度が減少する不都合がある。本発明の目的は、半導体層が酸化膜を介して半導体基板上に重ね合わされているＳＯＩ基板において、酸化膜と半導体基板との界面の引張り結合強度を増大させることのできるＳＯＩ基板の製造方法を提供することにある。

【０００４】

【課題を解決するための手段】請求項１に係る発明は、図１に示すように、第１半導体基板１１の表面に酸化膜１２を形成する工程と、第１半導体基板１１の酸化膜１２上に窒化膜１３を形成する工程と、第１半導体基板１

１の表面から水素イオンを注入して第１半導体基板１１内部にイオン注入領域１１ａを形成する工程と、窒化膜１３を第１半導体基板１１から除去する工程と、第１半導体基板１１を酸化膜１２を介して第２半導体基板１４に重ね合わせて密着させる工程と、第１半導体基板１１を第２半導体基板１４に密着させたまま所定の温度で熱処理して第１半導体基板１１を上記イオン注入した領域１１ａで第２半導体基板１４から分離して第２半導体基板１４の表面に半導体層１１ｂを形成する工程と、表面に半導体層１１ｂを有する第２半導体基板１４を更に熱処理する工程とをこの順に含むＳＯＩ基板の製造方法である。第１半導体基板１１表面の酸化膜１２の上に窒化膜１３を積層し、この上から水素イオンを注入して第１半導体基板１１内部にイオン注入領域１１ａを形成した後、窒化膜１３を除去するようにしたから、有機物などの汚染物質が窒化膜１３表面に残留した場合でも、上汚染物質は窒化膜１３と共に酸化膜１２の表面から除去される。従って、酸化膜１２の面荒れは防止され、酸化膜１２と第２半導体基板１４との界面の引張り結合強度は増大する。

【０００５】請求項２に係る発明は、図２に示すように、第１半導体基板１１の表面に酸化膜１２を形成する工程と、第１半導体基板１１に上記表面から水素イオンを注入して第１半導体基板１１内部にイオン注入領域１１ａを形成する工程と、第１半導体基板１１の酸化膜１２を酸素プラズマ処理する工程と、第１半導体基板１１を酸化膜１２を介して第２半導体基板１４に重ね合わせて密着させる工程と、第１半導体基板１１を第２半導体基板１４に密着させたまま所定の温度で熱処理して第１半導体基板１１を上記イオン注入した領域１１ａで第２半導体基板１４から分離して第２半導体基板１４の表面に半導体層１１ｂを形成する工程と、表面に半導体層１１ｂを有する第２半導体基板１４を更に熱処理する工程とをこの順に含むＳＯＩ基板の製造方法である。第１半導体基板１１表面の酸化膜１２の上から水素イオンを注入して第１半導体基板１１内部にイオン注入領域１１ａを形成した後、酸化膜１２の表面を酸素プラズマ処理するようにしたから、酸化膜１２表面に生成された有機物等の汚染物質は酸素プラズマ処理により除去されて、酸化膜１２の表面は清浄化される。従って、酸化膜１２の面荒れは防止され、酸化膜１２と第２半導体基板１４との界面の引張り結合強度は増大する。

【０００６】請求項３に係る発明は、図２に示すように、第１半導体基板１１の表面に酸化膜１２を形成する工程と、第１半導体基板１１に上記表面から水素イオンを注入して第１半導体基板１１内部にイオン注入領域１１ａを形成する工程と、第１半導体基板１１の酸化膜１２の表面を研磨する工程と、第１半導体基板１１を酸化膜１２を介して第２半導体基板１４に重ね合わせて密着させる工程と、第１半導体基板１１を第２半導体基板１４に密着させたまま所定の温度で熱処理して第１半導体基板１１を上記イオン注入した領域１１ａで第２半導体基板１４から分離して第２半導体基板１４の表面に半導体層１１ｂを形成する工程と、表面に半導体層を有する第２半導体基板１４を更に熱処理する工程とをこの順に含むＳＯＩ基板の製造方法である。第１半導体基板１１表面の酸化膜１２の上から水素イオンを注入して第１半導体基板１１内部にイオン注入領域１１ａを形成した後、酸化膜１２の表面を研磨するようにしたから、酸化膜１２表面に生成された有機物等の汚染物質は表面研磨処理により除去されて、酸化膜１２の表面は清浄化される。従って、酸化膜１２の面荒れは防止され、酸化膜１２と第２半導体基板１４との界面の引張り結合強度は増大する。

【０００７】

【発明の実施の形態】次に本発明の実施の形態を図面に基づいて説明する。図１に示すように、請求項１に係る本発明のＳＯＩ基板を製造するには、先ずシリコンウェーハからなる第１半導体基板１１を熱酸化により基板１１表面に絶縁層である酸化膜１２を形成する（図１（ａ））。次いで酸化膜１２上にＣＶＤ法により窒化膜１３を形成する。この窒化膜１３は１～１００ｎｍ、好ましくは５～３０ｎｍ程度の厚さになるように形成される。次いで酸化膜１２及び窒化膜１３を含む基板１１の表面から水素イオンを１～１０×１０^{16}／ｃｍ^{2}のドーズ量及び１～６００ｋｅＶの加速エネルギーでイオン注入する。その結果、基板１１内部にイオン注入領域１１ａが酸化膜１２に平行に形成される（図１（ｃ））。その後、窒化膜１３を熱燐酸を用いたウェットエッチング又はCF_4とO_2ガスを用いたドライエッチングの手段により除去して酸化膜１２を露出させる（図１（ｄ））。この窒化膜１３の除去により、その表面に残留した有機物などの汚染物質が窒化膜１３とともに酸化膜１２の表面から除去されて、酸化膜１２の表面は清浄化され、酸化膜１２の面荒れは防止される。

【０００８】次いで上記基板１１と同一表面積を有するシリコンウエーハからなる第２半導体基板１４を用意し（図１（ｂ））、第２基板１４上に第１基板１１を酸化膜１２を介して重ね合せて密着させる（図１（ｅ））。第１基板１１を第２基板１４に密着させたまま窒素雰囲気中で５００～８００℃の範囲に昇温し、５～３０分保持して薄膜分離熱処理を行う。これにより第１半基板１１が水素イオンの注入ピーク位置に相当するイオン注入領域１１ａのところで割れて上部の厚肉部１１ｃと下部の薄膜１１ｂに分離する（図１（ｆ））。次に温度を下げて厚肉部１１ｃを取除き（図１（ｈ））、酸化膜１２及び薄膜１１ｂを表面に有する第２基板１４を酸素又は窒素雰囲気中において９００～１２００℃で３０～１２０分間熱処理して薄膜１１ｂと第２基板１４とを強固に貼り合わせる（図１（ｇ））。更に薄膜１１ｂの分離面

及び厚肉部１１ｃの分離面をそれぞれ研磨（タッチポリッシング）して平滑化する（図１（ｉ）及び図１（ｊ））。これにより第２基板１４はＳＯＩ基板となり、厚肉部１１ｃは新たな半導体基板として再びＳＯＩ基板の製造に利用できる。

【０００９】図２に示すように、請求項２及び請求項３に係る本発明のＳＯＩ基板を製造するには、請求項１の場合と同様に、先ずシリコンウェーハからなる第１半導体基板１１を熱酸化により基板１１表面に絶縁層である酸化膜１２を形成する（図２（ａ））。次いで酸化膜１２を含む基板１１の表面から水素イオンを１～１０×１$0^{16}$／ｃm^2のドーズ量及び１～６００ｋｅＶの加速エネルギーでイオン注入する。その結果、基板１１内部にイオン注入領域１１ａが酸化膜１２に平行に形成される（図２（ｃ））。次に酸化膜１２の表面を均一に酸素プラズマ処理するか、又は研磨処理する（図２（ｄ））。研磨処理はシリコンウエーハ研磨機、レンズ研磨機などにより軽く行われる。プラズマ処理又は研磨処理により酸化膜は２０ｎｍ以下、好ましくは１～１０ｎｍ程度の深さまで磨滅させる。この酸素プラズマ処理の温度は後述する図２（ｆ）で示す薄膜分離熱処理の温度より低い４００℃以下の温度で行うことが好ましい。これは酸素プラズマ処理が薄膜分離熱処理よりも高い温度で行われた場合には第１基板１１と第２基板１４を重ね合せる前の段階においてイオン注入領域１１ａでシリコンウエーハが割れてしまう恐れがあるためである。その結果、酸化膜１２表面に生成された有機物等の汚染物質は酸化膜１２の表面から除去されて、酸化膜１２の表面は清浄化され、酸化膜１２の面荒れは防止される。

【００１０】次いで上記基板１１と同一表面積を有するシリコンウエーハからなる第２半導体基板１４を用意し（図２（ｂ））、第２基板１４上に第１基板１１を酸化膜１２を介して重ね合せて密着させる（図２（ｅ））。第１基板１１を第２基板１４に密着させたまま請求項１の場合と同様の条件で薄膜分離熱処理を行う。これにより第１半基板１１がイオン注入領域１１ａのところで割れて上部の厚肉部１１ｃと下部の薄膜１１ｂに分離する（図２（ｆ））。次に温度を下げて厚肉部１１ｃを取除き（図２（ｈ））、酸化膜１２及び薄膜１１ｂを表面に有する第２基板１４を請求項１の場合と同様の条件で熱処理して薄膜１１ｂと第２基板１４とを強固に貼り合わせる（図２（ｇ））。更に薄膜１１ｂの分離面及び厚肉部１１ｃの分離面をそれぞれ研磨して平滑化する（図２（ｉ）及び図２（ｊ））。これにより酸化膜１２と薄膜１１ｂを表面に有する第２基板１４からなるＳＯＩ基板を得る。

【００１１】

【実施例】次に本発明の具体的態様を示すために、本発明の実施例を比較例とともに説明する。

＜実施例１＞図１（ａ）に示すように、第１シリコン基板１１を熱酸化して表面に厚さ４００ｎｍの酸化膜１２を形成し、続いて酸化膜１２上にＣＶＤ法により厚さ５０ｎｍの窒化膜１３を形成した（図１（ａ））。次いでこの第１基板１１に６０ｋｅＶの電圧を印加して水素イオンを７×１$0^{16}$／ｃm^2のドーズ量でイオン注入して第１基板１１内部にイオン注入領域１１ａを酸化膜１２に平行に形成した（図１（ｃ））。その後、窒化膜１３を１４５～１５０℃の熱燐酸で除去した（図１（ｄ））。次いで上記基板１１と同一表面積を有する第２シリコン基板１４を用意し（図１（ｂ））、第２基板１４上に第１基板１１を酸化膜１２を介して重ね合せて密着させた（図１（ｅ））。第１基板１１を第２基板１４に密着させたまま窒素雰囲気中で６００℃の温度で３０分間熱処理を行った。その結果、第１基板１１がイオン注入領域１１ａのところで割れて上部の厚肉部１１ｃと下部の薄膜１１ｂに分離した（図１（ｆ））。次に温度を下げて厚肉部１１ｃを取除き（図１（ｈ））、酸化膜１２及び薄膜１１ｂを表面に有する第２基板１４を窒素雰囲気中において１１００℃で１時間熱処理して実施例１のＳＯＩ基板を製造した（図１（ｇ））。

【００１２】＜実施例２＞図２（ａ）に示すように、第１シリコン基板１１を熱酸化して表面に厚さ４００ｎｍの酸化膜１２を形成した（図１（ａ））。次いでこの第１基板１１に６０ｋｅＶの電圧を印加して水素イオンを７×１$0^{16}$／ｃm^2のドーズ量でイオン注入して第１基板１１内部にイオン注入領域１１ａを酸化膜１２に平行に形成した（図１（ｃ））。次に酸化膜１２の表面を酸素プラズマ処理した（図２（ｄ））。次いで第１基板１１と同一表面積を有する第２シリコン基板１４を用意し（図２（ｂ））、第２基板１４上に第１基板１１を酸化膜１２を介して重ね合せて密着させた（図２（ｅ））。第１基板１１を第２基板１４に密着させたまま窒素雰囲気中で６００℃の温度で３０分間熱処理を行った。その結果、第１基板１１がイオン注入領域１１ａのところで割れて上部の厚肉部１１ｃと下部の薄膜１１ｂに分離した（図２（ｆ））。次に温度を下げて厚肉部１１ｃを取除き（図２（ｈ））、酸化膜１２及び薄膜１１ｂを表面に有する第２基板１４を窒素雰囲気中において１１００℃で１時間熱処理して実施例２のＳＯＩ基板を製造した（図２（ｇ））。

【００１３】＜比較例１＞窒化膜１３を酸化膜１２上に形成しなかったことを除いては実質的に実施例１の方法を繰返して比較例１のＳＯＩ基板を製造した。

【００１４】＜比較評価＞実施例１、実施例２及び比較例１のそれぞれのＳＯＩ基板について、酸化膜１２と第２シリコン基板１４との界面の引張り強度をセバスチャンＶの試験方法を用いて調べた。その結果を表１に示す。なお、セバスチャンＶの試験方法は平坦な頭部を有する釘状のピンを用意し、接着剤を用いてこの平坦な頭部を薄膜１１ｂに接着し、このピンを引き下げる方法で

ある。この引き下げたときに酸化膜１２と第２シリコン基板１４との界面及び接着界面が剥離するときの強度を引張り強度とする。

【００１５】

【表１】

	実施例１	実施例２	比較例１
引張り強度(kg/cm²)	755	782	389

【００１６】表１から明らかなように、実施例１及び２の引張り強度は比較例１の約２倍と大きいことが判る。

【００１７】

【発明の効果】以上述べたように、本発明によれば、表面に酸化膜を有する第１半導体基板に水素イオンを注入して第１半導体基板内部にイオン注入領域を形成し、第１半導体基板を上記酸化膜を介して第２半導体基板に重ね合わせて密着させ、熱処理して第１半導体基板を上記イオン注入した領域で第２半導体基板から分離することにより第２半導体基板の表面に上記酸化膜を介して半導体層が形成されたＳＯＩ基板の製造方法において、水素イオンを注入する前に酸化膜の上に窒化膜を形成し、水素イオンの注入後に、窒化膜を除去するか、又は上記イオン注入の後に酸素プラズマ処理又は研磨処理することにより上記酸化膜の表面を清浄化することができる。この結果、酸化膜の表面には好ましくない有機物などの汚染物質が蓄積する恐れはなくなり、酸化膜の面荒れは防止され、酸化膜と第２半導体基板との界面の引張り結合強度を増大することができる。

【図面の簡単な説明】

【図１】本発明の実施形態の第１のＳＯＩ基板の製造方法を工程順に示す図。

【図２】本発明の実施形態の第２及び第３のＳＯＩ基板の製造方法を工程順に示す図。

【符号の説明】

１１　第１半導体基板

１１ａ　イオン注入領域

１１ｂ　薄膜

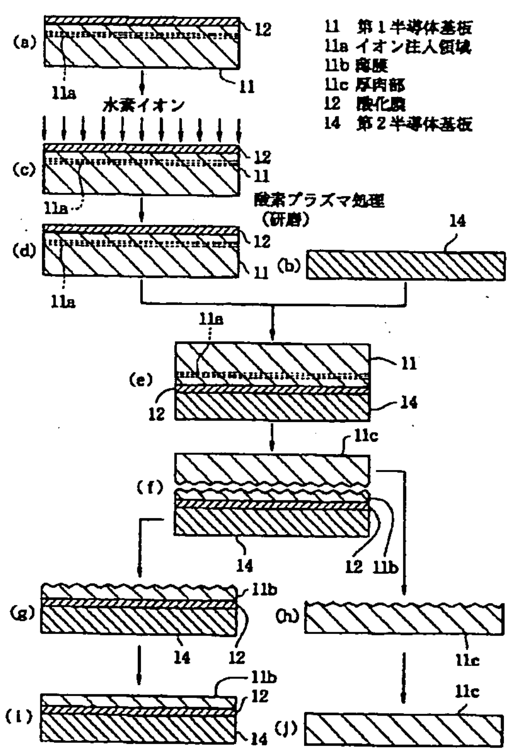
１１ｃ　厚肉部１１ｃ

１２　酸化膜

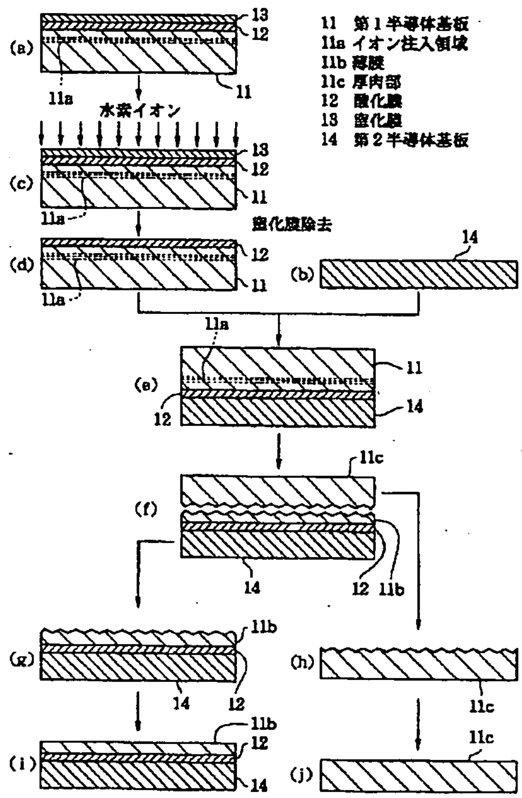
１３　窒化膜

１４　第２半導体基板

【図２】



【図1】


11　第1半導体基板
11a イオン注入領域
11b 薄膜
11c 厚肉部
12　酸化膜
13　窒化膜
14　第2半導体基板
水素イオン
窒化膜除去
(a)
(b)
(c)
(d)
(e)
(f)
(g)
(h)
(i)
(j)

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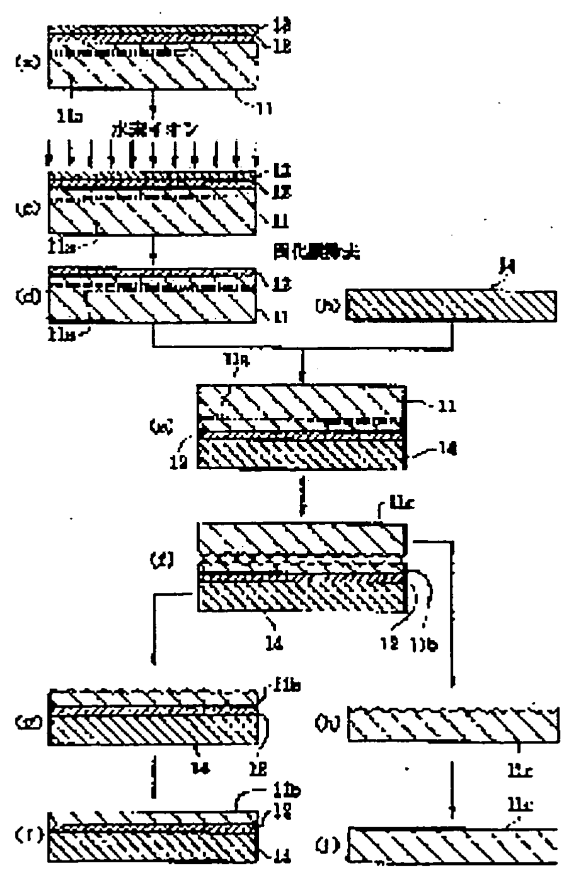
TOMIZAWA KENJI

(54) PRODUCTION OF SOI SUBSTRATE

(57)Abstract:
PROBLEM TO BE SOLVED: To obtain an SOI substrate having a semiconductor layer superposed on a semiconductor substrate through an oxide in which tensile bonding strength is increased on the interface between the oxide and the semiconductor substrate.
SOLUTION: An oxide 12 is deposited on the surface of a first semiconductor substrate 11 and a nitride 13 is deposited thereon. Hydrogen ions are implanted from the surface of the first semiconductor substrate 11 to form an ion implanted region 11a in the first semiconductor substrate. Subsequently, the nitride 13 is removed from the first semiconductor substrate and a second semiconductor substrate is superposed tightly thereon through the oxide 12. Under that state, it is heat-treated and the first semiconductor substrate is isolated from the second semiconductor substrate in the ion implanted region 11a thus forming a semiconductor layer 11b on the surface of the second semiconductor substrate. Finally, the second semiconductor substrate having the semiconductor layer 11b is further heat treated.



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CLAIMS

[Claim(s)]

[Claim 1] The process which forms an oxide film (12) in the front face of the 1st semi-conductor substrate (11), The process which forms a nitride (13) on the oxide film (12) of said 1st semi-conductor substrate (11), The process which pours in a hydrogen ion from the front face of said 1st semi-conductor substrate (11), and forms an ion-implantation field (11a) in the interior of said 1st semi-conductor substrate (11), The process which removes said nitride (13) from said 1st semi-conductor substrate (11), The process which piles up and sticks said 1st semi-conductor substrate (11) to the 2nd semi-conductor substrate (14) through said oxide film (12), Said 1st semi-conductor substrate (11) has been stuck to the 2nd semi-conductor substrate (14). The process which heat-treats at predetermined temperature, separates said 1st semi-conductor substrate (11) from said 2nd semi-conductor substrate (14) in said field (11a) which carried out the ion implantation, and forms a semi-conductor layer (11b) in the front face of said 2nd semi-conductor substrate (14), The manufacture approach of the SOI substrate which includes the process which heat-treats further said 2nd semi-conductor substrate (14) which has a semi-conductor layer (11b) on a front face in this order.

[Claim 2] The process which forms an oxide film (12) in the front face of the 1st semi-conductor substrate (11), The process which injects a hydrogen ion into said 1st semi-conductor substrate (11) from said front face, and forms an ion-implantation field (11a) in the interior of said 1st semi-conductor substrate (11), The process which carries out oxygen plasma treatment of the oxide film (12) of said 1st semi-conductor substrate (11), The process which piles up and sticks said 1st semi-conductor substrate (11) to the 2nd semi-conductor substrate (14) through said oxide film (12), Said 1st semi-conductor substrate (11) has been stuck to the 2nd semi-conductor substrate (14). The process which heat-treats at predetermined temperature, separates said 1st semi-conductor substrate (11) from said 2nd semi-conductor substrate (14) in said field (11a) which carried out the ion implantation, and forms a semi-conductor layer (11b) in the front face of said 2nd semi-conductor substrate (14), The manufacture approach of the SOI substrate which includes the process which heat-treats further said 2nd semi-conductor substrate (14) which has a semi-conductor layer (11b) on a front face in this order.

[Claim 3] The process which forms an oxide film (12) in the front face of the 1st semi-conductor substrate (11), The process which injects a hydrogen ion into said 1st semi-conductor substrate (11) from said front face, and forms an ion-implantation field (11a) in the interior of said 1st semi-conductor substrate (11), The process which grinds the front face of the oxide film (12) of said 1st semi-conductor substrate (11), The process which piles up and sticks said 1st semi-conductor substrate (11) to the 2nd semi-conductor substrate (14) through said oxide film (12), Said 1st semi-conductor substrate (11) has been stuck to the 2nd semi-conductor substrate (14). The process which heat-treats at predetermined temperature, separates said 1st semi-conductor substrate (11) from said 2nd semi-conductor substrate (14) in said field (11a) which carried out the ion implantation, and forms a semi-conductor layer (11b) in the front face of said 2nd semi-conductor substrate (14), The manufacture approach of the SOI substrate which includes the process which heat-treats further said 2nd semi-conductor substrate (14) which has a semi-conductor layer (11b) on a front face in this order.

DETAILED DESCRIPTION

[Detailed Description of the Invention]
[0001]
[Field of the Invention] This invention relates to the manufacture approach of a SOI (Silicon On Insulator) substrate of having prepared the semi-conductor layer on the insulator layer.
[0002]
[Description of the Prior Art] This kind of SOI substrate has attracted attention as a future ultra-large scale integrated circuit (ULSI) substrate. SIMOX which carries out annealing treatment at an elevated temperature, forms a pad silicon oxidizing zone in the field of the predetermined depth from this silicon substrate surface, and makes an active region the Si layer by the side of that front face after pouring high-concentration oxygen ion into the interior of the approach of making a silicon thin film depositing on the substrate which has the approach, ** insulation substrate, or the insulating thin film which sticks ** silicon substrates on the manufacture approach of this SOI substrate through an insulator layer on a front face, and ** silicon substrate -- there is law etc. Moreover, a temperature up is carried out to the temperature which crosses an ion-implantation side for this semi-conductor substrate, and crosses 500 degrees C for superposition and this layered product to a support substrate as a superposition side after injecting a hydrogen ion etc. into a semi-conductor substrate recently, the above-mentioned semi-conductor substrate is separated from a support substrate in the field which poured in the above-mentioned hydrogen ion etc., and the manufacture approach of a thin semiconductor material film of having a thin film on the front face of a support substrate is proposed (JP,5-211128,A). By this approach, if ion can be poured into homogeneity from a front face inside a semi-conductor substrate, the semi-conductor substrate which has the thin film of uniform thickness will be obtained. Moreover, if the oxide film is beforehand prepared in the front face of a support substrate, a SOI substrate can be manufactured by this approach.
[0003]
[Problem(s) to be Solved by the Invention] However, in the oxide-film front face of the semi-conductor substrate with which the above-mentioned hydrogen ion impregnation is performed, there is a problem which contaminants, such as the organic substance which remained on the oxide-film front face, deteriorate by hydrogen ion impregnation, and becomes that it is hard to be removed in the usual wet etching before pouring in a hydrogen ion, and a field dry area produces on an oxide-film front face. Consequently, there is un-arranging [for which the tension bond strength of the interface of the oxide film of the above-mentioned semi-conductor substrate and a support substrate decreases] under the effect of the above-mentioned pollutant and a field dry area. The purpose of this invention has a semi-conductor layer in offering the manufacture approach of a SOI substrate that the tension bond strength of the interface of an oxide film and a semi-conductor substrate can be increased in the SOI substrate piled up on a semi-conductor substrate through an oxide film.
[0004]
[Means for Solving the Problem] The process at which invention concerning claim 1 forms an oxide film 12 in the front face of the 1st semi-conductor substrate 11 as shown in drawing 1 , The process which forms a nitride 13 on the oxide film 12 of the 1st semi-conductor substrate 11, The process which pours in a hydrogen ion from the front face of

the 1st semi-conductor substrate 11, and forms ion-implantation field 11a in the 1st semi-conductor substrate 11 interior, The process which removes a nitride 13 from the 1st semi-conductor substrate 11, and the process which piles up and sticks the 1st semi-conductor substrate 11 to the 2nd semi-conductor substrate 14 through an oxide film 12, The process which dissociates from the 2nd semi-conductor substrate 14 by field 11a which heat-treated at predetermined temperature, sticking the 1st semi-conductor substrate 11 to the 2nd semi-conductor substrate 14, and carried out [above-mentioned] the ion implantation of the 1st semi-conductor substrate 11, and forms semi-conductor layer 11b in the front face of the 2nd semi-conductor substrate 14, It is the manufacture approach of the SOI substrate which includes the process which heat-treats further the 2nd semi-conductor substrate 14 which has semi-conductor layer 11b on a front face in this order. The laminating of the nitride 13 is carried out on the oxide film 12 of 1st semi-conductor substrate 11 front face, and even when pollutants, such as the organic substance, remain on nitride 13 front face since the nitride 13 was removed after pouring in the hydrogen ion from on this and forming ion-implantation field 11a in the 1st semi-conductor substrate 11 interior, an upper pollutant is removed from the front face of an oxide film 12 with a nitride 13. Therefore, the field dry area of an oxide film 12 is prevented, and the tension bond strength of the interface of an oxide film 12 and the 2nd semi-conductor substrate 14 increases.

[0005] The process at which invention concerning claim 2 forms an oxide film 12 in the front face of the 1st semi-conductor substrate 11 as shown in drawing 2 , The process which injects a hydrogen ion into the 1st semi-conductor substrate 11 from the above-mentioned front face, and forms ion-implantation field 11a in the 1st semi-conductor substrate 11 interior, The process which carries out oxygen plasma treatment of the oxide film 12 of the 1st semi-conductor substrate 11, and the process which piles up and sticks the 1st semi-conductor substrate 11 to the 2nd semi-conductor substrate 14 through an oxide film 12, The process which dissociates from the 2nd semi-conductor substrate 14 by field 11a which heat-treated at predetermined temperature, sticking the 1st semi-conductor substrate 11 to the 2nd semi-conductor substrate 14, and carried out [above-mentioned] the ion implantation of the 1st semi-conductor substrate 11, and forms semi-conductor layer 11b in the front face of the 2nd semi-conductor substrate 14, It is the manufacture approach of the SOI substrate which includes the process which heat-treats further the 2nd semi-conductor substrate 14 which has semi-conductor layer 11b on a front face in this order. Since it was made to carry out oxygen plasma treatment of the front face of an oxide film 12 after pouring in the hydrogen ion from on the oxide film 12 of 1st semi-conductor substrate 11 front face and forming ion-implantation field 11a in the 1st semi-conductor substrate 11 interior, pollutants, such as the organic substance generated by oxide-film 12 front face, are removed by oxygen plasma treatment, and the front face of an oxide film 12 is defecated. Therefore, the field dry area of an oxide film 12 is prevented, and the tension bond strength of the interface of an oxide film 12 and the 2nd semi-conductor substrate 14 increases.

[0006] The process at which invention concerning claim 3 forms an oxide film 12 in the front face of the 1st semi-conductor substrate 11 as shown in drawing 2 , The process which injects a hydrogen ion into the 1st semi-conductor substrate 11 from the above-mentioned front face, and forms ion-implantation field 11a in the 1st semi-conductor substrate 11 interior, The process which grinds the front face of the oxide film 12 of the

1st semi-conductor substrate 11, and the process which piles up and sticks the 1st semi-conductor substrate 11 to the 2nd semi-conductor substrate 14 through an oxide film 12, The process which dissociates from the 2nd semi-conductor substrate 14 by field 11a which heat-treated at predetermined temperature, sticking the 1st semi-conductor substrate 11 to the 2nd semi-conductor substrate 14, and carried out [above-mentioned] the ion implantation of the 1st semi-conductor substrate 11, and forms semi-conductor layer 11b in the front face of the 2nd semi-conductor substrate 14, It is the manufacture approach of the SOI substrate which includes the process which heat-treats further the 2nd semi-conductor substrate 14 which has a semi-conductor layer on a front face in this order. Since the front face of an oxide film 12 was ground after pouring in the hydrogen ion from on the oxide film 12 of 1st semi-conductor substrate 11 front face and forming ion-implantation field 11a in the 1st semi-conductor substrate 11 interior, pollutants, such as the organic substance generated by oxide-film 12 front face, are removed by surface polish processing, and the front face of an oxide film 12 is defecated. Therefore, the field dry area of an oxide film 12 is prevented, and the tension bond strength of the interface of an oxide film 12 and the 2nd semi-conductor substrate 14 increases.

[0007]

[Embodiment of the Invention] Next, the gestalt of operation of this invention is explained based on a drawing. As shown in drawing 1 , in order to manufacture the SOI substrate of this invention concerning claim 1, the oxide film 12 which is an insulating layer on substrate 11 front face about the 1st semi-conductor substrate 11 which consists of a silicon wafer first is formed by thermal oxidation (drawing 1 (a)). Subsequently, a nitride 13 is formed with a CVD method on an oxide film 12. Preferably, 1-100nm of this nitride 13 is formed so that it may become the thickness of about 5-30nm. Subsequently, the ion implantation of the hydrogen ion is carried out with the dose of one to 10x1016-/cm2, and the acceleration energy of 1-600keV from the front face of the substrate 11 containing an oxide film 12 and a nitride 13. Consequently, ion-implantation field 11a is formed in the substrate 11 interior in parallel with an oxide film 12 (drawing 1 (c)). Then, the means of dry etching using the wet etching or CF4 andO2 gas using heat phosphoric acid removes a nitride 13, and an oxide film 12 is exposed (drawing 1 (d)). Pollutants, such as the organic substance which remained on that front face, are removed from the front face of an oxide film 12 with a nitride 13, the front face of an oxide film 12 is defecated by removal of this nitride 13, and the field dry area of an oxide film 12 is prevented by it.

[0008] Subsequently, the 2nd semi-conductor substrate 14 which consists of a silicon wafer which has the same surface area as the above-mentioned substrate 11 is prepared (drawing 1 (b)), and the 1st substrate 11 is piled up and stuck through an oxide film 12 on the 2nd substrate 14 (drawing 1 (e)). A temperature up is carried out to the range of 500-800 degrees C in nitrogen-gas-atmosphere mind, sticking the 1st substrate 11 to the 2nd substrate 14, it holds for 5 to 30 minutes, and thin film separation heat treatment is performed. thereby -- the -- by the way, ion-implantation field 11a by which 1 half substrate 11 is equivalent to the impregnation peak location of a hydrogen ion breaks, and it separates into upside heavy-gage part 11c and lower thin film 11b (drawing 1 (f)). Next, temperature is lowered, heavy-gage part 11c is removed (drawing 1 (h)), the 2nd substrate 14 which has an oxide film 12 and thin film 11b on a front face is heat-treated for 30 - 120 minutes at 900-1200 degrees C in oxygen or nitrogen-gas-atmosphere mind, and thin

film 11b and the 2nd substrate 14 are stuck firmly (drawing 1 (g)). Furthermore, the separation side of thin film 11b and the separation side of heavy-gage part 11c are ground, respectively (touch polishing), and are graduated (drawing 1 (i) and drawing 1 (j)). Thereby, the 2nd substrate 14 turns into a SOI substrate, and heavy-gage part 11c can use it for manufacture of a SOI substrate again as a new semi-conductor substrate.

[0009] As shown in drawing 2 , in order to manufacture the SOI substrate of this invention concerning claim 2 and claim 3, the oxide film 12 which is an insulating layer on substrate 11 front face about the 1st semi-conductor substrate 11 which consists of a silicon wafer first is formed by thermal oxidation like the case of claim 1 (drawing 2 (a)). Subsequently, the ion implantation of the hydrogen ion is carried out from the front face of the substrate 11 containing an oxide film 12 with the dose of one to 10x1016-/cm2, and the acceleration energy of 1-600keV. Consequently, ion-implantation field 11a is formed in the substrate 11 interior in parallel with an oxide film 12 (drawing 2 (c)). Next, oxygen plasma treatment of the front face of an oxide film 12 is carried out to homogeneity, or polish processing is carried out (drawing 2 (d)). Polish processing is lightly performed by a silicon wafer grinder, the lens grinder, etc. 20nm or less of oxide films is preferably worn in Mr. about 1-10nm Fukashi by plasma treatment or polish processing. As for the temperature of this oxygen plasma treatment, it is desirable to carry out at the temperature of 400 degrees C or less lower than the temperature of thin film separation heat treatment shown by drawing 2 (f) mentioned later. This is because there is a possibility that a silicon wafer may break in ion-implantation field 11a in the phase before piling up the 1st substrate 11 and the 2nd substrate 14, when oxygen plasma treatment is performed at temperature higher than thin film separation heat treatment. Consequently, pollutants, such as the organic substance generated by oxide-film 12 front face, are removed from the front face of an oxide film 12, the front face of an oxide film 12 is defecated, and the field dry area of an oxide film 12 is prevented.

[0010] Subsequently, the 2nd semi-conductor substrate 14 which consists of a silicon wafer which has the same surface area as the above-mentioned substrate 11 is prepared (drawing 2 (b)), and the 1st substrate 11 is piled up and stuck through an oxide film 12 on the 2nd substrate 14 (drawing 2 (e)). Thin film separation heat treatment is performed on the same conditions as the case of claim 1, sticking the 1st substrate 11 to the 2nd substrate 14. thereby -- the -- 1 half substrate 11 is ion-implantation field 11a -- by the way, it is divided and separates into upside heavy-gage part 11c and lower thin film 11b (drawing 2 (f)). Next, temperature is lowered, heavy-gage part 11c is removed (drawing 2 (h)), the 2nd substrate 14 which has an oxide film 12 and thin film 11b on a front face is heat-treated on the same conditions as the case of claim 1, and thin film 11b and the 2nd substrate 14 are stuck firmly (drawing 2 (g)). Furthermore, the separation side of thin film 11b and the separation side of heavy-gage part 11c are ground, respectively, and are graduated (drawing 2 (i) and drawing 2 (j)). The SOI substrate which consists of an oxide film 12 and the 2nd substrate 14 which has thin film 11b on a front face by this is obtained.

[0011]

[Example] Next, in order to show the concrete mode of this invention, the example of this invention is explained with the example of a comparison.

As shown in <example 1> drawing 1 (a), the oxide film 12 with a thickness of 400nm was

formed in the front face, the 1st silicon substrate 11 was oxidized thermally and the nitride 13 with a thickness of 50nm was continuously formed with the CVD method on the oxide film 12 (drawing 1 (a)). Subsequently, the electrical potential difference of 60keV(s) was impressed to this 1st substrate 11, the ion implantation of the hydrogen ion was carried out with the dose of 7x1016-/cm2, and ion-implantation field 11a was formed in the 1st substrate 11 interior in parallel with an oxide film 12 (drawing 1 (c)). Then, 145-150-degree C heat phosphoric acid removed the nitride 13 (drawing 1 (d)). Subsequently, the 2nd silicon substrate 14 which has the same surface area as the above-mentioned substrate 11 was prepared (drawing 1 (b)), and the 1st substrate 11 was piled up and stuck through the oxide film 12 on the 2nd substrate 14 (drawing 1 (e)). Heat treatment was performed for 30 minutes at the temperature of 600 degrees C in nitrogen-gas-atmosphere mind, sticking the 1st substrate 11 to the 2nd substrate 14. Consequently, it was divided in the place whose 1st substrate 11 is ion-implantation field 11a, and separated into upside heavy-gage part 11c and lower thin film 11b (drawing 1 (f)). Next, temperature was lowered, heavy-gage part 11c was removed (drawing 1 (h)), the 2nd substrate 14 which has an oxide film 12 and thin film 11b on a front face was heat-treated at 1100 degrees C in nitrogen-gas-atmosphere mind for 1 hour, and the SOI substrate of an example 1 was manufactured (drawing 1 (g)).

[0012] As shown in <example 2> drawing 2 (a), the 1st silicon substrate 11 was oxidized thermally and the oxide film 12 with a thickness of 400nm was formed in the front face (drawing 1 (a)). Subsequently, the electrical potential difference of 60keV(s) was impressed to this 1st substrate 11, the ion implantation of the hydrogen ion was carried out with the dose of 7x1016-/cm2, and ion-implantation field 11a was formed in the 1st substrate 11 interior in parallel with an oxide film 12 (drawing 1 (c)). Next, oxygen plasma treatment of the front face of an oxide film 12 was carried out (drawing 2 (d)). Subsequently, the 2nd silicon substrate 14 which has the same surface area as the 1st substrate 11 was prepared (drawing 2 (b)), and the 1st substrate 11 was piled up and stuck through the oxide film 12 on the 2nd substrate 14 (drawing 2 (e)). Heat treatment was performed for 30 minutes at the temperature of 600 degrees C in nitrogen-gas-atmosphere mind, sticking the 1st substrate 11 to the 2nd substrate 14. Consequently, it was divided in the place whose 1st substrate 11 is ion-implantation field 11a, and separated into upside heavy-gage part 11c and lower thin film 11b (drawing 2 (f)). Next, temperature was lowered, heavy-gage part 11c was removed (drawing 2 (h)), the 2nd substrate 14 which has an oxide film 12 and thin film 11b on a front face was heat-treated at 1100 degrees C in nitrogen-gas-atmosphere mind for 1 hour, and the SOI substrate of an example 2 was manufactured (drawing 2 (g)).

[0013] If it removed having not formed the <example 1 of comparison> nitride 13 on the oxide film 12, the approach of an example 1 was repeated substantially and the SOI substrate of the example 1 of a comparison was manufactured.

[0014] The tensile strength of the interface of an oxide film 12 and the 2nd silicon substrate 14 was investigated using Sebastian's V test method about each SOI substrate of the <comparative-evaluation> example 1, an example 2, and the example 1 of a comparison. The result is shown in Table 1. In addition, Sebastian's V test method is an approach of preparing the pin of the shape of a nail which has a flat head, pasting up this

flat head on thin film 11b using adhesives, and pulling down this pin. When [this] you reduce, let reinforcement in case the interface and adhesion interface of an oxide film 12 and the 2nd silicon substrate 14 exfoliate be tensile strength.

[0015]

[Table 1]

	実施例1	実施例2	比較例1
引張り強度(kg/cm²)	755	782	389

[0016] It turns out [the twice / about / of the example 1 of a comparison, and] that the tensile strength of examples 1 and 2 is large so that clearly from Table 1.

[0017]

[Effect of the Invention] As stated above, according to this invention, inject a hydrogen ion into the 1st semi-conductor substrate which has an oxide film on a front face, and an ion-implantation field is formed in the interior of the 1st semi-conductor substrate. The 1st semi-conductor substrate is piled up and stuck to the 2nd semi-conductor substrate through the above-mentioned oxide film. In the manufacture approach of a SOI substrate that the semi-conductor layer was formed in the front face of the 2nd semi-conductor substrate through the above-mentioned oxide film by dissociating from the 2nd semi-conductor substrate in the field which heat-treated and carried out [above-mentioned] the ion implantation of the 1st semi-conductor substrate Before pouring in a hydrogen ion, a nitride can be formed on an oxide film, a nitride can be removed after impregnation of a hydrogen ion, or the front face of the above-mentioned oxide film can be defecated oxygen plasma treatment or by carrying out polish processing after the above-mentioned ion implantation. Consequently, a possibility that pollutants, such as the organic substance which is not desirable, may be accumulated on the surface of an oxide film disappears, and the field dry area of an oxide film is prevented and can increase the tension bond strength of the interface of an oxide film and the 2nd semi-conductor substrate.

DESCRIPTION OF DRAWINGS

[Brief Description of the Drawings]
[Drawing 1] Drawing showing the manufacture approach of the 1st SOI substrate of the operation gestalt of this invention in order of a process.
[Drawing 2] Drawing showing the manufacture approach of the 2nd of the operation gestalt of this invention, and the 3rd SOI substrate in order of a process.
[Description of Notations]
11 1st Semi-conductor Substrate
11a Ion-implantation field
11b Thin film
11c Heavy-gage part 11c
12 Oxide Film
13 Nitride
14 2nd Semi-conductor Substrate